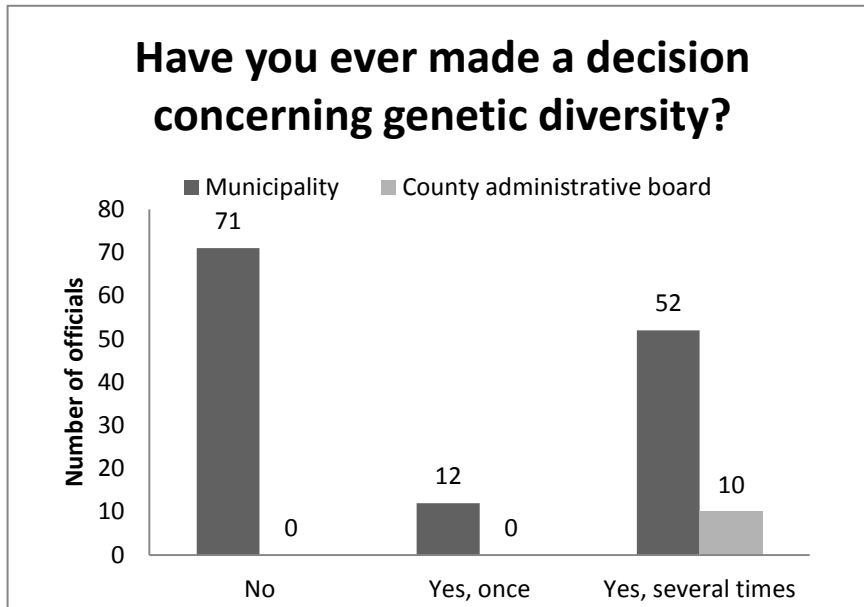


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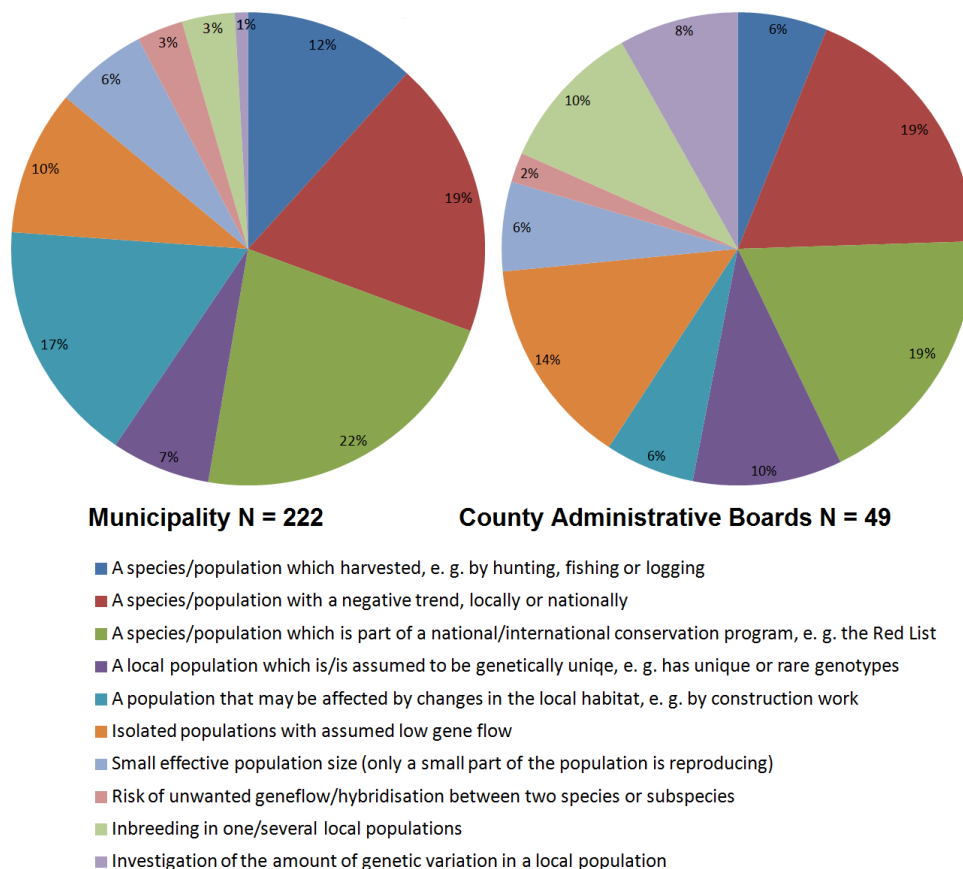
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Figur 3. Answers to the question: "Have you ever had to make a decision concerning the need to monitor and/or protect genetic diversity at your current place of work?" Differences between the two groups of officials are significant at $p=0.000576$ (Fisher's Exact test).

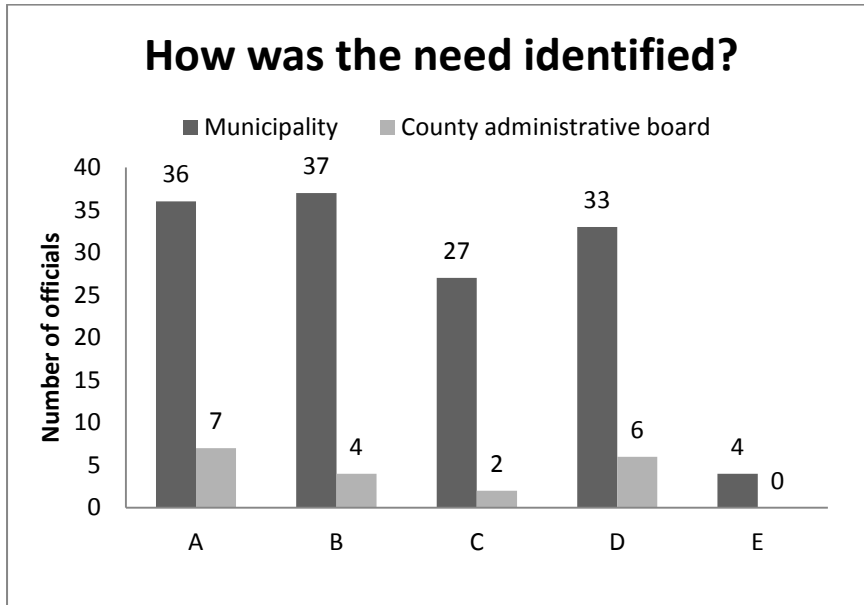
The decisions concerning the need to monitor and/or protect genetic diversity concerned several different fields of genetics and varied between the two groups of officials. At the Municipalities, officials did more often consider species/populations that are harvested or affected by changes in their habitat, such as construction work than officials at County Administrative Boards did (17 vs. 6%). On the other hand, 10% of the officials at County Administrative Boards had considered inbred populations, compared to 3% of the officials at the Municipalities. Figure 4 illustrates the decisions divided between the two groups of officials.

What did the decision concern?



Figur 4. Decisions including genetic aspects made by officials at the two governmental levels listed below the figures and marked in different colors. The sizes of the pie charts indicate the relative amounts of officials that had made one or several decisions of that kind. Several options were possible to indicate in the survey.

The officials at County Administrative Boards most often identified the need to monitor and/or protect genetic diversity within their organization or by the fact that the general status of the species indicated a need for monitoring. Officials at the Municipalities also often identified the need within the organization or from the general status of the species, but were also much more likely to receive the information from someone outside the organization, either from someone who identified in his/her profession, or from a person who had identified it during a non-profit work or hobby. Figure 5 illustrate this.



Figur 5. Illustration of how the need to monitor and/or protect genetic diversity was identified at the two governmental levels. Several options were possible. A: I/my colleague identified the need. B: A person outside my organization identified the need as a part of his/her professional duty e.g. during an environmental impact assessment. C: A person outside my organization identified the need during non-profit work or as a part of his/her hobby. D: The general status of the species concerned is considered to call for monitoring/conservation. E: Other.

3.2.4 Species

The species that were mentioned as having been discussed in terms of genetic conservation differed between the two groups of participants, 11 species were mentioned by employees at County Administrative Boards and 48 by employees at municipalities. In total, 56 species were mentioned in the study. Only three species were mentioned by both groups, these species were the Clouded Apollo (*Parnassius mnemosyne*), the Hermit Beetle (*Osmoderma eremita*) and the Spring Pasque Flower (*Pulsatilla vernalis*). The species mentioned most often was the Great Crested Newt (*Triturus cristatus*), the Freshwater Pearl Mussel (*Margaritifera margaritifera*) and the Hermit Beetle (*Osmoderma eremita*), which were all mentioned by five different officials. In the cases of the mussel and the newt, all officials that had worked with them were employed at the municipal level.

All species, except one, that was mentioned by employees at County Administrative Boards are both on the Swedish Red List and in the program for Action Plans for Threatened species. In contrast, employees at the Municipality level mentioned 17 species that are only protected by the Red List, 3 species that have an Action Plan but are currently not Red Listed, and 22 species that are both Red Listed and

have an Action Plan. A summary of the number of species from each red list category that were mentioned in the survey can be found in table 1. In table 2, the numbers of species which have Action Plans and were mentioned by officials from each group are listed, along with the percentage of the 400 species that have an action plan, which were covered in this survey.

Tabell 1. Summary of species from each red list category. (RE: Regionally Extinct, CR: Critically Endangered, EN: Endangered, VU: Vulnerable, NT: Near Threatened, DD: Data Deficient)

Red List Status	County Administrative Board	Municipality
Not listed	0	9
NT	2	12
VU	1	11
EN	5	13
CR	2	3
RE	0	0
DD	1	0
Total	11	48

Tabell 2. Summary of numbers of species with and without Action Plans and the percentage of species with Action Plans covered by the study mentioned by officials as County Administrative Boards and Municipalities, respectively

Action Plan	County Administrative Board	Municipality
Yes	10	25
No	1	23
Total	11	54
% of total species with Action Plans	2,5	6,25

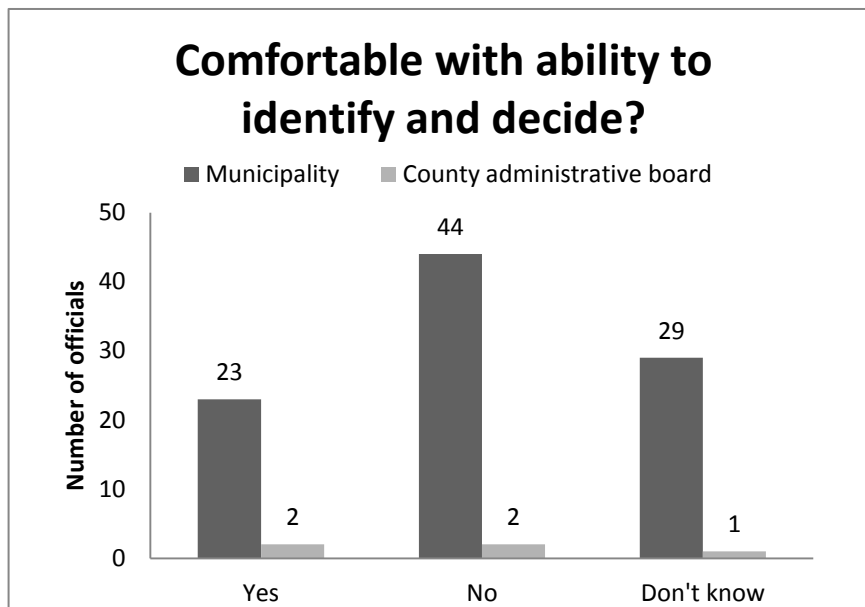
Interestingly, six of the species that had been discussed in terms of genetic considerations at Swedish Municipalities were neither on the Swedish Red List, nor in the program for the Swedish Action Plans for Threatened species. This means that 10.7 % of the species mentioned by officials participating in the questionnaire survey do not benefit from any form of strict legislative protection in Sweden.

In Appendix 4, all the 56 species that were mentioned in the survey are listed with Swedish and English trivial names, scientific names, the number of times the species was mentioned in the survey, and where the official who mentioned it was working. Appendix 4 also contains information on whether the species is part of

the Swedish Action Plans for Threatened species, and if it is currently on the Swedish Red List.

3.2.5 Situation at work place

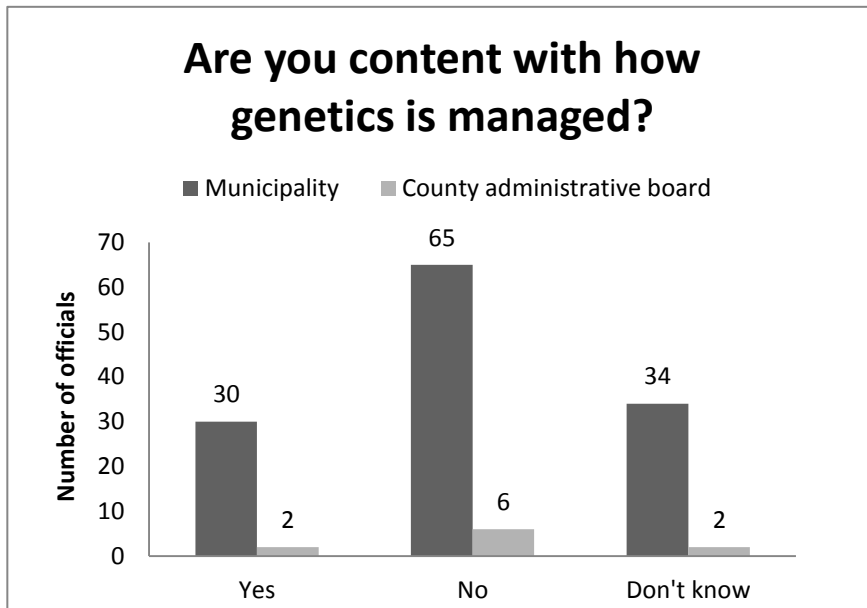
At both governmental levels, many officials were not comfortable with their own or their colleagues ability to identify and make decisions in matters concerning genetic diversity. At the municipal level, 24% answered that they were comfortable with their ability to make decisions related to genetic diversity, whereas 45,8% were not and 30,2% were not sure. At the County Administrative Boards, two out of five officials were comfortable with their ability to make decisions in genetics, two were not, and one was not sure. Neither of the two officials that were comfortable with their ability to identify such situations had participated in a course in genetics. There were no significant differences between the two groups of officials in terms of how comfortable they were with their ability to make decisions in genetics. The results from this question are illustrated in figure 6.



Figur 6. Answers to the question "Are you comfortable with your own/your colleagues ability to identify and make decisions in matters concerning genetic diversity?"

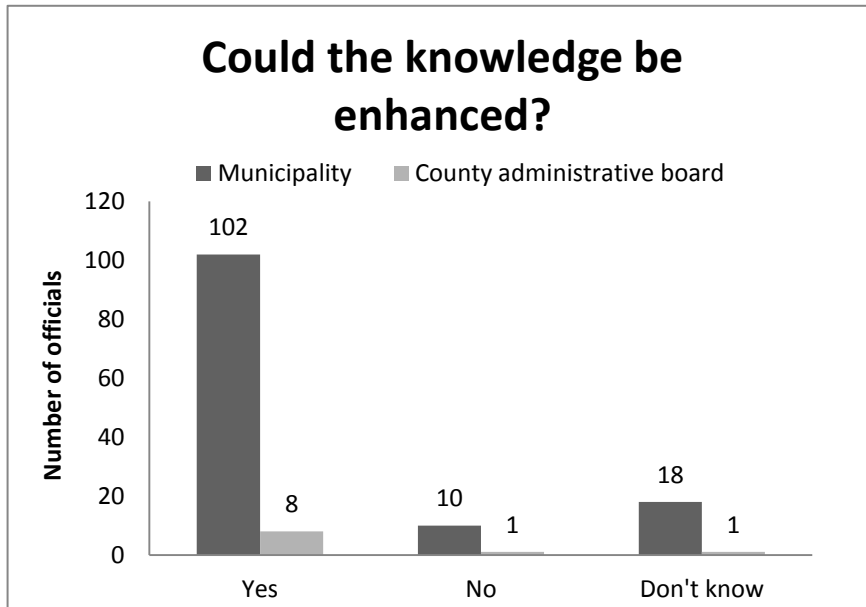
At both governmental levels, most officials were not content with how genetics was managed at their place of work. At the municipal level, 50.4% were discontent, 23.3% were content and 26.4% were unsure. Six out of ten officials at the

County Administrative Boards replied that they were discontent, two were content and two were unsure. These trends are illustrated in figure 7.



Figur 7. Answers to the question "Are you content with how questions concerning genetics are managed at your place of work?"

A majority of the officials at both levels of government thought that the knowledge about genetic issues could be enhanced at their work place. Eight out of ten officials at the County Administrative Boards and 78.5% of the officials at the municipalities thought that the knowledge about genetic issues could be enhanced at their work place. Their answers are illustrated in figure 8.



Figur 8. Answers to the question if the knowledge in genetics could be enhanced at the work place.

4 Discussion

In this thesis work, a questionnaire study was performed among officials working with nature conservation at Swedish County Administrative Boards and Municipalities. The aim of the study was to investigate if and how officials at these governmental institutions work with conserving genetic diversity. A literature review was also performed, with the aim of investigating how genetic diversity is protected in the Swedish legislation. In this section, the results from the questionnaire study will be discussed in relation to the legislative obligations of the two governmental institutions.

4.1.1 Are officials working with genetics?

As expected, all officials at County Administrative Boards had made decisions about the need to monitor and/or conserve genetic diversity, while most officials at the Municipalities had not been in a situation where they had to make such a decision. I expected that this situation would be a consequence of the legislative obligations of the County Administrative Boards, but there may be several other reasons for the tendency of officials at County Administrative Boards to work with genetic issues more often than officials at the municipal level. For example, there may be differences in amount of time available for this type of work between the two groups of officials. The selection of target groups may also have influenced the results. Although demographic and educational factors such as gender and level of education in genetics did not differ between the two groups, the mere process of how they were selected to participate in the study did differ.

As the two governmental institutions that participated in the study are structured in different ways, the selection of officials that were invited to participate in the study had to be performed in two different ways, which may, to some extent, have influenced the outcome of the study. At the level of County Administrative Boards, the contact person on the page for Action Plans for Threatened species at

the homepage was asked to participate in the questionnaire study. At the level of Municipalities, employees working with nature conservation or environment were asked to participate in the study, but if no such person could be found via the homepage of the municipality in question, an employee working with more general environmental issues was contacted and asked to participate. This difference in how the target groups were selected was inevitable as the County Administrative Boards and Municipalities are structured quite differently in Sweden. Nevertheless, this difference could also be reflected in the results found in the study, as participants from the County Administrative Boards may be working more specifically with nature conservation in general and protection of rare species in particular.

The questionnaire study also revealed that officials at County Administrative Boards tend to have more colleagues with similar knowledge about genetics as themselves, whereas officials working with nature conservation at the Municipalities tend to be more isolated in their work. This difference may influence the work performed at the two institutions, not the least by limiting the time and resources available for each employee to consider questions concerning genetic resources.

4.1.2 Type of genetic resources

The types of genetic resources that have been considered by the officials vary a bit between the two levels of governance. For example, the results indicate that officials at Municipalities more often had considered species/populations that are harvested or that are affected by changes in their habitat, such as construction work. At the County Administrative Boards on the other hand, officials had more often considered isolated or inbred populations and were more likely to investigate the amount of genetic variation in a local population. These trends are in line with what was expected as officials at County Administrative Boards are working with species that have an action plan, whereas officials at the Municipality level tend to work on a variety of tasks, including planning and Environmental Impact Assessments.

The study revealed no difference between the groups in terms of how genetic resources that need conservation measures were identified. However, there appeared to be a trend indicating that the Municipalities more often obtain such information from the general public. This may be an effect of the scale hierarchy of the Swedish governmental system, which may simply make it more logic for the general public to contact the local Municipality if he/she finds something interest-

ing/rare in the nature, than to contact the County Administrative Board in the region.

4.1.3 Species

The species that have been taken into consideration due to their genetics also varied between the two levels of government. At the municipal level, both species that are protected by the Red List or an Action Plan and species that are not protected at all were mentioned. At the County Administrative Boards, on the other hand, all species that were mentioned are legally protected. This difference was also expected, as the Municipalities work on a more local scale than County Administrative Boards, which may cause them to notice small changes in the local environment and/or populations of species at an earlier stage the County Administrative Boards do. However, the findings also raise questions regarding the priorities in the work with genetic conservation in Sweden. In most cases, the County Administrative Boards have the national responsibility for the Action Plans (the Environmental Protection Agency, List of Action Plans in production), so naturally the main part of their work should involve such species. In addition, the officials that represented the County Administrative Boards in the survey were selected from people working specifically with the Action Plans for Threatened Species, which further indicates that these officials should have been working with species that have Action Plans.

Commonly mentioned species

Out of all the species mentioned in the survey, three were mentioned as much as five times. These species had a few things in common; they all have action plans and are all associated with habitats that are also threatened. The Hermit Beetle (*Osmoderma eremita*) is a rare beetle associated with the species rich but increasingly rare habitat provided by old oaks in the open landscape (Antonsson (ed.), 2001). This species is strongly protected and is both Red Listed and has an Action Plan. Thus, it is not so strange that officials in both target groups have been working with this species.

The Great Crested Newt (*Triturus cristatus*) and the Fresh Water Pearl Mussel (*Margaritifera margaritifera*) are the other two species that were mentioned most often in the survey. Just like the Hermit Beetle, these two species have Action Plans and are thus rather strictly protected. Despite having the same level of protection as the Hermit Beetle, these two species were only mentioned by officials at

the municipal level. This difference may be due to a combination of the type of habitat that the species prefer and the differences in the responsibilities between the Municipalities and the County Administrative Boards. The officials from the County Administrative Boards which participated in the survey are working with the protection of species per se, whereas the work at the Municipalities can have a broader approach and concern any species which officials come across in their work. In accordance with the legislative obligations of the Municipalities, much of the work at this level of governance involves construction projects covered by the Planning and Building Act, so officials at the municipalities may often come across species that are threatened by construction projects.

The Great Crested Newt is a species that is strongly associated with the less and less common “pondscapes”; open grasslands with patches of forests and small, preferably fish free ponds (Malmgren, 2007). Such landscapes are often a matter for construction projects, which may explain why it is only mentioned by officials at the Municipalities; these officials may simply be more likely to come across the species in relation to development of municipal comprehensive plans and Environmental Impact Assessments. In fact, in the Action Plan for the Newt, it is specifically stated that it may often be more natural for Municipalities than County Administrative Boards to come across this species (Malmgren, 2007).

As for the Fresh Water Pearl Mussel, its status is threatened from many different factors, such as forestry, decreasing water quality and hydroelectric power stations. The latter mainly influence the populations of mussels by decreasing the populations of trout (*Salmo trutta*) and salmon (*Salmo salar*), two species that serve as host for the mussels larvae and play an important role in its development (Schreiber et al, 2005). These human activities mentioned above are often related to the work performed at the municipalities, which may be the reason why the endangered mussel has also been discussed at this level. In addition, the Action Plan for the species explicitly states that some of the work with protecting the Fresh Water Pearl Mussel will be performed at the municipal level (Schreiber et al, 2005).

Species that are not formally protected

At the municipal level, several officials also mentioned that they had taken the genetics of more common and (at least not yet) endangered species into consideration. It may be argued that these types of considerations are not needed for species that are not threatened. However, one may also argue the contrary; that such species indeed should be taken into account in the conservation work at the different

governmental levels in Sweden, not the least in the current situation where biological systems all over the world are undergoing great changes. If officials working with conservation are familiar with the status also of the species that are not formally protected, it is plausible that any ongoing changes could be detected at a very early stage. Of course, rare species are still in the most urgent need of conservation measures, and with a limited budget, these species do need to be prioritized. Yet, I want to argue that the local knowledge of populations and species which are not rare or threatened is very important, both when trying to identify changes, and when trying to gain public support of the conservation work. The common, not yet threatened but easily seen and recognized species, might even prove valuable as “flagship species” for their local habitat. At the Municipalities, this protection of more common species may prove extra valuable as the Municipalities have a more executive role in Swedish land management and work on a more local scale than County Administrative Boards (Hahn et al, 2006), a fact which may enable them to notice (and prevent with) small changes in the local environment at an early stage.

4.1.4 Situation at work place

The questionnaire survey revealed the alarming situation that most officials at both levels of governance were neither comfortable with their own nor their colleagues ability to identify matters of concern that are related to genetic diversity. In addition, most officials were also discontent with how question concerning genetics are managed at their place of work. One possibility is that that this is an effect of officials being rather well educated in the field of genetics, but are suffering from the Dunning-Kruger effect, which causes the level of confidence to decrease with the level of knowledge in a certain field, and vice versa (Kruger, 1999). Since officials at both governmental levels are rather well educated in the field of genetics, they might also be more aware of the flaws in their work and mainly see the parts of it that need improvement.

However, as officials also suggest that their knowledge concerning genetics could be enhanced, the Dunning-Kruger effect is probably not the sole reason for this problem, as officials with little knowledge then would overestimate their own abilities and not want to learn more about the conservation of genetic diversity.

4.1.5 Legislative obligations to conserve genetics

Apart from the questionnaire study, this thesis work included a literature review of the obligations for Municipalities and County Administrative Boards to conserve

genetics. In the work with the literature review, a few things came clear; first, very few parts of the Swedish national legislation explicitly state anything about genetics but that several sections cover the topic in a less direct way. Second, the evaluations available of the work with for example the fulfillment of the obligations in the CBD indicate that even less is done in practice.

The Swedish work with the CBD has been evaluated by the Swedish Environmental Protection Agency in four National Reports, in 1998, 2001, 2005 and 2009 (<http://www.cbd.int/reports/search/>). In the most recent Swedish National Report, it was concluded that the interim target *Halting the loss of biodiversity* (Ministry of the Environment, 2009), would probably not be fulfilled within the given time-frame, i. e. before 2010. This was concluded as nearly three out of four natural habitat types, and around half of the species targeted did not, at the time of the study, enjoy a favorable conservation status. Also, the species on the Swedish Red List were still declining, as were several previously common species (Ministry of the Environment, 2009). In this thesis work, nothing has been found that would indicate that these trends have been halted, at least not if the value of how content officials are with the work performed at their current work place can be used as a measure of how the work is going.

As for the genetic aspects of biodiversity, the National report (Ministry of the Environment, 2009) merely concluded that the work to halt the losses had only recently begun, and that Swedish conservation work was focusing on species rich biotopes and substrates, whereas other aspects of biodiversity were less well known, including the levels of species and genetics (Ministry of the Environment, 2009). This, too, is a situation that still appears to persist, despite the fact that the Ministry of the Environment (2009) did recognize that the Environmental Quality Objective A Rich Diversity of Plant and Animal Life is based on the CBD and its levels of landscapes, species and genetics.

Finally, the Ministry of the Environment (2009) concluded that the CBD goal of promoting the conservation of genetic diversity of the wild fauna and flora in Sweden by 2010 will only partially be met. The main reasons for this was that the plans for an assessment and monitoring program would not be operational by 2010, and that even basic knowledge about genetic diversity was still limited in most taxonomic groups. Despite all this, it was concluded in the report that the most severe obstacles preventing the fulfillment of the CBD goal of conservation of genetic diversity in Sweden was the low level of recognition of this goal among decision-makers, and the lack of funding (Ministry of the Environment, 2009). This was concluded despite that the questionnaire study from 2006 found that little

is done to conserve genetic diversity, despite a high level of recognition among decision makers (Environmental Protection Agency, 2006).

Nevertheless, it is clear that the Environmental Objectives are, and should be, integrated into the work at the Municipalities and County Administrative Boards. At all levels of governance, the Objectives should be adjusted to integrate the environmental objectives into the rest of the work performed, that is, in planning, development of green areas, and as a part of the work with the Swedish Environmental Code and the Swedish Planning and Building Act (Miljö- och samhällsbyggnadsdepartementet, 2005). Such an integration of the objectives into other fields could be give adequate attention to the Environmental Objectives in general and the Objective on Biodiversity and genetic diversity in particular.

Lately, the Environmental Protection Agency (2012) has detected a potentially positive trend in the work with the environmental goals at the Swedish municipalities. In their annual report on the work with the environmental objective, it was suggested that even though the general public often has a very limited knowledge about biological diversity, the political interest in these matters has increased as a result of financial investments.

4.1.6 Methodology

The methods used in this study could be improved in several ways. In this section, the methodology used is discussed in terms of pros, cons and potential for improvements.

Uneven sample sizes

Already when designing the study, it was clear that the sample sizes between the two target groups would be rather uneven. This was expected as a consequence of the number of Municipalities found in Sweden is so much higher than the number of County Administrative Boards (290 compared to 21). In the end, sample sizes were indeed very uneven, as 137 officials at the Municipal level and ten from the County Administrative Boards participated in the study. This uneven sample size did of course influence how the data could be analyzed (see section on statistics).

There are several ways in which these uneven sample sizes could have been avoided; however, all of these come with drawbacks. One solution could have been to randomly sample 21 Municipalities from the 290, thus asking equally large groups to participate. However, this could still have led to unequal groups as there was no guarantee that any answers at all would appear. Furthermore, such sampling would most likely have been skewed, as any map of the country can re-

veal that there are more and smaller Municipalities in the south than in the north. Thus, a randomly drawn Municipality would be more likely to be located in the south than in the north, and a study based on such randomly drawn samples would risk to not fully cover the situation in the country as a whole.

Another way to avoid the risk of uneven sample sizes would have been to randomly pick one Municipality from each County. However, this would still involve the risk of uneven sample sizes, as it was impossible to know how many answers the study would result in.

Thus, one official from each Municipality was invited to participate in the survey. Primarily because of the risk of not getting enough answers, but also because the situation where little was known about what type of work was really performed at this level and all information had to be thought of as interesting information. In the cases when several Municipalities collaborate in their environmental work and only had one office and one contact person, only one person was invited to participate in the survey. This was done in order to avoid pseudo replication.

Contact information

No official or easily accessed lists of e-mail addresses to suitable contact persons at the two levels of governance were available when the survey should be distributed. Therefore, as described in the methods section above, contact information had to be searched for at the web pages of the Municipalities and County Administrative Boards. This method of searching for information was not ideal, as there was a risk that the “wrong” person would be asked to participate in the survey. An alternative might have been to contact all Municipalities and County Administrative Boards before sending out the invitation, and ask for a specific contact person. However, that would have come with the risk of having to wait for 290 plus 21 answered e-mails, many of which might have never been answered at all.

Answering frequencies

Another factor that deserves to be discussed is the answering frequencies in the study. In both groups, around half of the officials asked to participate did so. As the survey was non-mandatory and not a part of their daily work, this can be regarded as a rather high number, as filling it in would have been something they did “outside” their normal duties. On the other hand, this also means that all results in this study are based on a subsample of the total group of officials asked to participate. The subsample must be regarded as nonrandom since we cannot exclude the

risk that the persons that choose to participate in the survey are more similar to each other than to the people that choose to not participate.

It is not unlikely that the people that choose to participate in a survey concerning genetics are those that in some way feel connected to the subject, either because it is a part of their education or because they are confronted with the issues in their daily work. Thus, it may be wise to regard the results from this study as “overly positive” in the sense that the people that have participated are the ones that know the most about genetics and/or work with it the most. Of course, the ones that are unhappy with how the work is performed would also be more likely to participate, but in order to be able to be unhappy about something, you need to have enough skills to be able identify the problem. In other words, there is a risk that this study reveals a brighter picture of the amount of work and the level of competence in genetics that is available at Swedish County Administrative Boards and Municipalities. Consequentially, it is probably wise to consider all numbers presented in this study as representing the “best case scenario”. In reality, the situation might be worse.

In conclusion, the only way to avoid the problems caused by officials choosing not to answer would have been to make a survey like this mandatory, e.g. by asking the Environmental Protection Agency to distribute it. However, the risk would then be that officials may be tempted to depict a slightly brighter picture than what is really the case, which may be worse than the opposite scenario.

The SLU Survey Generator

One major issue with the whole questionnaire survey was the survey generator selected. In its original design, the survey was meant to control the way officials could answer questions, so that if they had answered “no” on question A, they should not be able to answer any subsequent question that was directed towards those who had answered “yes” on question A. This, however, was one of the technical functions of the SLU Survey Generator which were out of order.

Another thing that did not work as it should was the function of making certain questions mandatory. Since this function did not work, the answering frequencies came to vary greatly between different questions, making it difficult to analyze them statistically.

Statistics

For the practical and technical reasons stated above, the questionnaire turned out to be hard to analyze statistically. One issue was that sample sizes were so uneven

that parametric tests were out of the question. In addition, due to a combination of technical problems with the survey generator and some questions being less well-reasoned, it was hard to find tests that were applicable on the data at hand.

In the end, the Fisher's Exact test was selected, as it was considered to be the most applicable test for the task. However, the results from the Fisher's Exact test will only tell if the data observed differs from the values expected in the null hypothesis. Thus, in reality, the test might not provide more information than the mere percentage values obtained in the study in the first place do. If the study was to be performed again, it would definitely be preferable with a study design that was easier to analyze statistically. On the other hand, the study design used did provide a lot of valuable information, which might not have been obtained if the statistical analysis had been the main goal.

4.1.7 Potential for further studies

Several questions have been raised during the process of working with this thesis. There is a lot of potential to further develop the study, by for example inviting other groups of officials to participate, to ask more questions, and to analyze the results even further.

First, it would be interesting to invite an even larger group of people to participate in the study. Given how the Swedish system of governance is built up, it would at least be interesting to also invite the politicians that are working with environmental issues and the officials at the two largest official agencies working with nature conservation and use of natural resources, i.e. the Environmental Protection Agency and the Swedish Agency for Marine and Water Management. By incorporating these levels of governance, it might be possible to get a more comprehensive picture of the work with conserving genetic diversity in Sweden. In addition, this approach could then be one step towards mapping out and describing the entire line of action associated with conservation of genetic diversity, from international legislations to local applications at the Municipalities.

Furthermore, it would be valuable to ask more questions, and to make them more specific. This could be done in several ways, either by using a more complex and technically functional survey generator, or by instead designing a study based on interviews. The first approach would have more potential in terms of statistical analysis and be more time and cost efficient, whereas the second might provide more valuable information since there would be more room for personal reflections.

